Knowledge Representation Tool for Cognitive Processes Modeling

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1. INTRODUCTION

In the last decades, neuropsychological theories tend to consider cognitive functions as a result of the whole brainwork and not as individual local areas of its cortex. Studies based on neuroimaging techniques have increased in the last years, promoting an exponential growth of the body of knowledge about relations between cognitive functions and brain structures [1]. However, so fast evolution make complicated to integrate them in verifiable theories and, even more, translated in to cognitive rehabilitation.

The aim of this research work is to develop a cognitive process-modeling tool. The purpose of this system is, in the first term, to represent multidimensional data, from structural and functional connectivity, neuroimaging, data from lesion studies and derived data from clinical intervention [2][3]. This will allow to identify consolidated knowledge, hypothesis, experimental designs, new data from ongoing studies and emerging results from clinical interventions. In the second term, we pursuit to use Artificial Intelligence to assist in decision making allowing to advance towards evidence based and personalized treatments in cognitive rehabilitation.

This work presents the knowledge base design of the knowledge representation tool. It is compound of two different taxonomies (structure and function) and a set of tags linking both taxonomies at different levels of structural and functional organization.

The remainder of the abstract is organized as follows: Section 2 presents the web application used for gathering necessary information for generating the knowledge base, Section 3 describes knowledge base structure and finally Section 4 expounds reached conclusions.

2. METHODS

Physiological and neuropsychological information contained in the knowledge base has been provided by clinical professionals from Institut Guttmann [4]. A specific web application has been designed for gathering this data, which allows therapists to add new elements to the knowledge base and/or to edit the existing ones.

This application consists of four different modules: structures, functions, pathways and circuits. System design is shown in Figure 1.

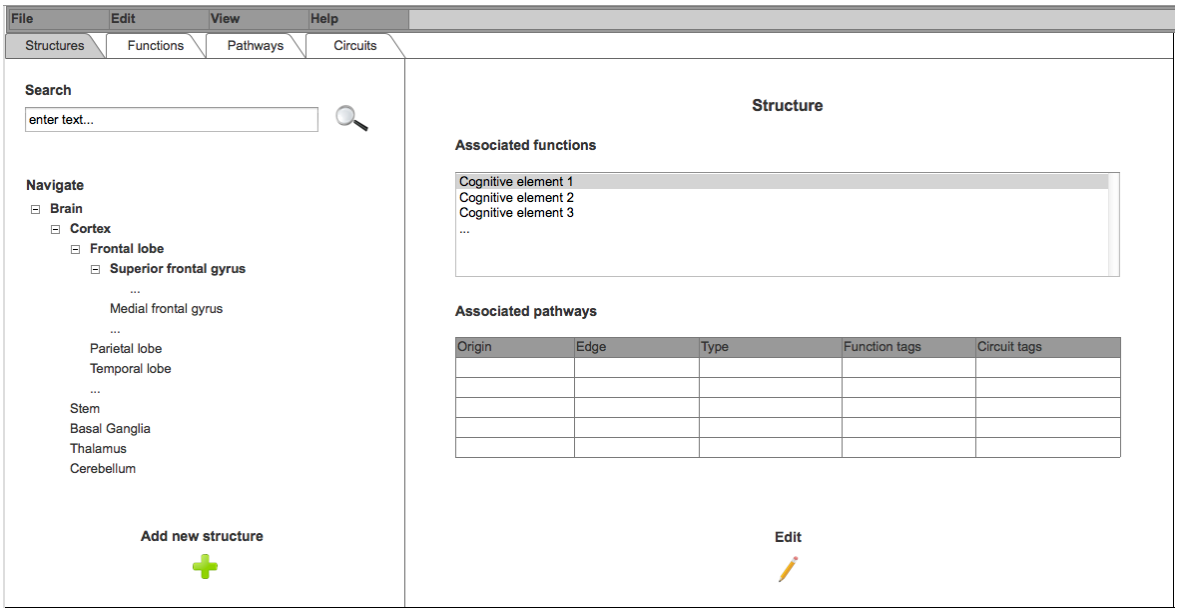

Figure 1. Interface design – Main view

3. RESULTS

The result obtained from this work is a knowledge base, which will be used for representing cognitive processes. This knowledge base is composed of two taxonomies (anatomical structure and brain function), which are connected at different structural and functional levels by a set of tags.

Taxonomy of anatomical structures

This taxonomy considers five principal divisions based on anatomical information: cortex, brain stem, basal ganglia, thalamus and cerebellum. Each division is subdivided into different levels depending on the specific physiological characteristics of every anatomical structure. Brain structures are classified according to this taxonomy specifying which hemisphere they belong to.

Furthermore, the pathways linking brain structures are also defined. A pathway is described by three parameters: origin anatomical structure, type of connection (depending on the synaptic mechanism involved in the transmission of information) and final anatomical structure. Two structures can be connected by one or more pathways, in one or both directions.

Taxonomy of cognitive functions

This taxonomy classifies cognitive processes. It starts from higher cognitive functions, such as attention, memory, language and executive function, until detailed functions described in neuropsychological literature. Three main sub-levels of this taxonomy have been defined: function, subfunction and cognitive element.

Linking tags

Structure and function taxonomies are linked through tags. Two kinds of tags are defined: network and function tags. The first one identifies brain structures that belong to a higher structural organization (circuits). The second one labels those brain structures, pathways and circuits that are involved in the cognitive process of a specific cognitive element.

4. CONCLUSIONS

This abstract presents a knowledge base as the first step for the development of a knowledge representation tool for cognitive processes modeling. A high complexity lies in the representation of cognitive processes and the management of treatment and assessment data, which results in an important technical challenge in the development of this tool.

The final goal of this tool is to generate scientific evidence on rehabilitation treatments by verifying or refuting therapeutic hypothesis.

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